MachineLibrary™ and Dynamic Stiffness: An Animated Tutorial

MachineLibrary™, recently expanded with Release 2, is Bently Nevada's comprehensive multimedia training CD-ROM. It uses powerful animations, 3D computer graphics, and interactive simulators to instruct on a wide variety of essential machinery diagnostic topics, including Dynamic Stiffness and Rotor Response.

The screen captures shown are taken from one of several animated tutorials which explain the principles that govern fundamental rotor response. Through tangible, easy-to-understand examples, the tutorials effectively explain Dynamic Stiffness and its relationship to rotor response. Figure 1, for example, illustrates three of the primary forces whose stiffnesses contribute to the Dynamic Stiffness of a rotor system. The accompanying

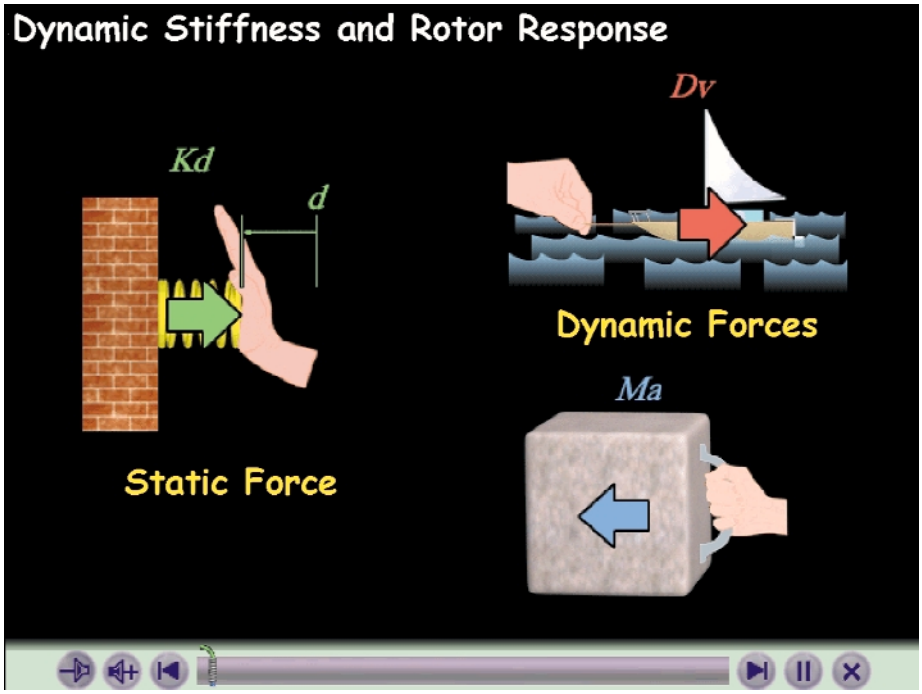

Figure 1. The three primary forces that contribute to the Dynamic Stiffness of a rotor system.

audio narration describes how the static force originates in a machine's spring-like elements, such as shafts, fluid-film bearings, and bearing supports. The elastic nature of these elements causes them to resist displacement with a force that is related to their spring stiffness (*K*).

Also described are the dynamic forces which, unlike the static force, depend upon stiffnesses that exist only when the rotor is in motion. The damping force occurs as moving parts push through surrounding lubrication and process fluids. The viscous nature of these fluids resists motion with a force related to their damping qualities (*D*). The inertia (*M*) of accelerating mass provides the source of mass stiffness in a rotor system.

The tutorial continues with a description of how these stiffnesses combine into an overall Dynamic Stiffness that is speed-dependent, as shown in Figure 2. A vector diagram uses color to relate the magnitude and directional quality of these stiffnesses to the angle between the rotor's heavy spot and high spot. It also shows that Dynamic Stiffness comprises the denominator of the rotor response equation.

Additional tutorials give detailed descriptions of other concepts that determine fundamental rotor response. Included are Lambda (λ) and the forces which act on a rotor: The Unbalance Force, The Spring Force, The Damping Force, The Tangential Force, and The Rotating Fluid Force. The interactive Rotor Response Simulator provides an opportunity to pull these concepts together, with real-time feedback to those changes which the user inputs to the simulator.

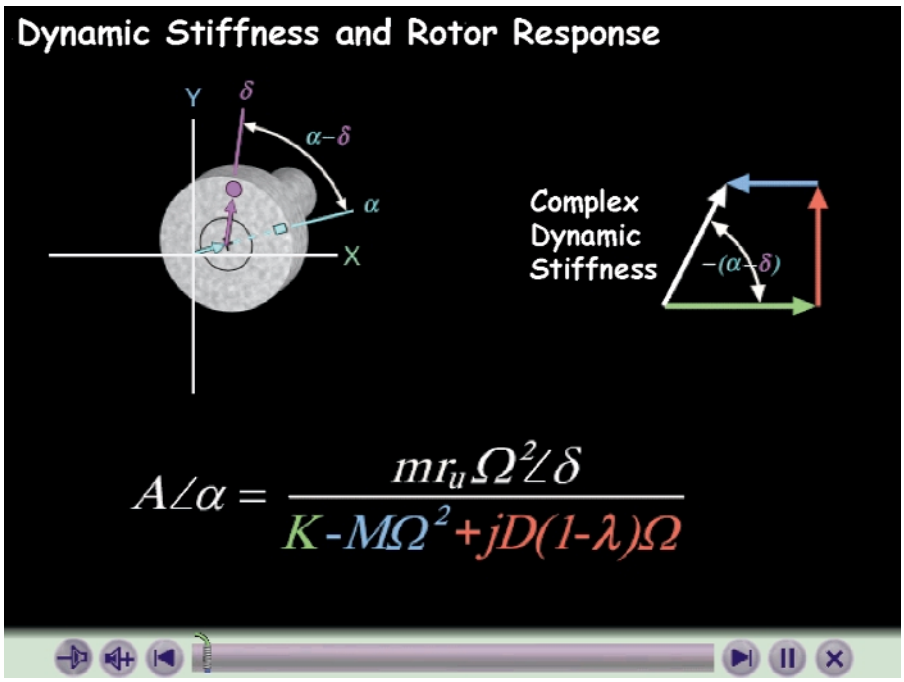

Figure 2. Mathematical and graphical representations of Dynamic Stiffness.

Navigation controls, seen at the bottom of each figure, allow the user to progress through each tutorial at a comfortable pace.

This is only a small portion of what MachineLibrary™ has to offer. More than 50 other tutorials explain vibration data plot construction, thermodynamics, and rotating machinery construction and malfunctions. An extensive library of well-illustrated articles covers common machine malfunctions, and advanced rotor dynamic concepts and research. There is even a set of machine malfunction case histories that accompanies their associated ADRE® (Automated Diagnostics for Rotating Equipment) databases and ADRE® DMi (DataModeler Interface), a read-only ADRE® database viewer.

For more information about MachineLibrary™, please refer to the Fourth Quarter 1999 ORBIT article, *A New Version of MachineLibrary™ Multimedia Training Package Is Now Available,* pp. 66-67, or visit the MachineLibrary™ page at our website, www.bently.com.